A.D. 1872, 26th *August*. N° 2538.

SPECIFICATION

OF

HENRY YOUNG DARRACOTT SCOTT.

TREATING SEWAGE.

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A.D. 1872, 26th *August*. N° 2538.

Treating Sewage.

LETTERS PATENT to Henry Young Darracott Scott, of Ealing, in the County of Middlesex, Major-General, C.B., for the Invention of "IMPROVEMENTS IN THE TREATMENT OF SEWAGE AND IN THE PREPARATION OF MANURES THEREFROM."

Sealed the 11th February 1873, and dated the 26th August 1872.

PROVISIONAL SPECIFICATION left by the said Henry Young Darracott Scott at the Office of the Commissioners of Patents, with his Petition, on the 26th August 1872.

I, HENRY YOUNG DARRACOTT SCOTT, of Ealing, in the County of Middlesex, Major-General, C.B., do hereby declare the nature of the said Invention for "IMPROVEMENTS IN THE TREATMENT OF SEWAGE AND IN THE PREPARATION OF MANURES THEREFROM," to be as follows :—

The object of this Invention is the purification of the sewage water of towns and manufactories, and the extraction therefrom of the ammonia which they contain in a form available for commercial purposes.

In carrying out my Invention I prefer to effect a preliminary removal of the grosser organic and other suspended impurities of the sewage either by precipitation or by mere subsidence without chemical assistance; but I consider the method of precipitation the best. To effect the precipitation I employ by preference (but I do not limit myself to this substance) calcined magnesian limestone or dolomite. This compound I partially dissolve in water (which for economy's sake may be the clarified sewage water resulting from the precipitation process), and the lime being more soluble than the magnesia of the compound I am enabled to run the dissolved lime (with a small proportion only of the magnesia accompanying it) into the sewage, and thus cause it to precipitate in a tank, which I will call tank No. 1. The deposit thus produced I dry and subject to a process of distillation such as is ordinarily employed in the preparation of charcoal. The products of distillation I collect for the sake of the tarry and ammoniacal compounds they contain; and the resulting charcoal will be found to possess in great intensity the peculiar properties of animal charcoal. The magnesia obtained from the dolomite is converted into phosphate of magnesia by any of the well-known processes, and I employ this in conjunction with the charcoal in the further purification of the effluent liquid from tank No. 1, and for the extraction of its ammonia.

The phosphate of magnesia and the powdered charcoal prepared as above described is agitated in tank No. 2 with the effluent sewage from No. 1, and a great excess of these deodorants is employed so as to insure that the sewage water shall be well filled with them, and that (to some extent at least) the perfection of fluid admixtures may be approximated to. After sufficient agitation the precipitate formed and the other solid substances are allowed to subside, and the supernatant water is run into tank No. 3.

In tank No. 3 I introduce (into the sewage water) a sufficiency of milk of lime to precipitate any phosphoric acid which may be carried away in solution from tank No. 2. I may here again with advantage employ some of the charcoal, and in certain cases I use the powdered charcoal in tank No. 3 only, and omit it in tank No. 2, where I then use phosphate of magnesia only. After the contents of No. 3 have been agitated together the precipitate formed is allowed to subside, and the supernatant water, if it be intended to purify it thoroughly, is passed through a filter bed of the charcoal; or of the charcoal combined with other filter beds of gravel, burned ballast, or other suitable substance.

It will be manifest that in lieu of agitating large quantities of the phosphate of magnesia and charcoal with the sewage water in tank No. 2, the effluent sewage may be passed from tank No. 1 through a filter bed of these substances in order to produce the results aimed at.

Again in lieu of agitating milk of lime with the sewage water in tank No. 3, the effluent sewage from No. 2 may be filtered through a filter formed of the calcareous substance produced by the complete calcination of the deposit from tank No. 1; or again, I may follow another course. I have only to urge the heat after the distillation process beyond the temperature required for the proper production of charcoal, and by the reaction of the carbonic acid in the deposit on the carbon of the organic matter carbonic oxide is formed and quicklime results. The compound of charcoal and quicklime thus produced may be employed for the removal of the phosphoric acid from the sewage from tank No. 2, either by agitation with it in the powdered form or when it is used as a filter bed.

In the case of employing the charcoal as a filter I prefer to subject the deposit from tank No. 1 to heavy pressure before converting it into charcoal. By this means I impart to the charcoal a density and cohesion which enables it to be granulated, as is done with ordinary animal charcoal, for which it may be substituted for a great variety of purposes. The deposits from tanks Nos. 2 and 3, or the filter beds after they have lost their properties of absorption and deodorization, may be dried and be sold for manure, either mixed together or separately. The sulphate of lime or other compound produced in obtaining the phosphate of magnesia may also be added to the deposits from tanks 2 and 3 with advantage in many cases.

Where also the dry closet system is in use in a town as well as the method of carrying by water, the charcoal from the deposit may be employed with advantage as the absorbent. In cases in which long carriage is necessary in order to dispose of the manure produced, I distil the ammonia from the deposits in No. 2 and 3 tanks into an acid solution, or through some other good absorbent or retainer of ammonia, and I use the recarbonized charcoal over again.

By adding the distilled ammonia to the manure I obtain the manure in a more concentrated form before sending it into the market.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Henry Young Darracott Scott in the Great Seal Patent Office on the 22nd February 1873.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, Henry Young Darracott Scott, of Ealing, in the County of Middlesex, Major-General, C.B., send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twenty-sixth day of August, in the year of our Lord One thousand eight hundred and seventy-two, in the thirty-sixth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Henry Young Darracott Scott, Her special licence that I, the said Henry Young Darracott Scott, my executors, administrators, and assigns, or such others as I, the said Henry Young Darracott Scott, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "Improvements in the Treatment of Sewage and in the Preparation of Manures therefrom," upon the condition (amongst others), that I, the said Henry Young Darracott Scott, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Henry Young Darracott Scott, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being had to the Drawing hereunto annexed, and to the letters and figures marked thereon (that is to say):—

The object of this Invention is, first, the cleansing of the polluted waters of towns and factories by the removal therefrom of the dissolved organic substances as well as the suspended impurities; and secondly, the extraction of the fertilizing elements from sewage matters (in which term I include night soil) in a form available for commercial purposes.

In carrying out my Invention I vary the details of the method of procedure according to circumstances, such as the ultimate destination of the effluent or the demand for the products which can be obtained from the sewage, and when it is necessary to remove all impurities I remove them not in one operation but stage by stage.

The general mode of procedure with liquid sewage consists, first, in the removal of the grosser impurities (which contain but a small proportion of its fertilizing elements) by precipitation with lime; secondly, in the conversion of the precipitated matters into charcoal (by modifying the conditions under which the organic matter is destroyed) when their conversion by complete calcination into agricultural lime or cement for building purposes (as proposed by me in Letters Patent, dated Twenty-sixth August, One thousand eight hundred and seventy-one, No. 2243,) is unadvisable; thirdly, in the extraction of organic matter and ammonia from the clarified effluent resulting from the lime process by one or more of the phosphatic precipitants described by me in Letters Patent, dated Twentieth March, One thousand eight hundred and seventy-two, No. 849, combined or not with the cleansing action of the charcoal resulting from the distillation of the lime deposit obtained under the first head; and, fourthly, in the further removal of the organic nitrogen and carbon compounds by means of a final filtration through or agitation with such charcoal, by which means I render the sewage water sufficiently pure to be run into the smallest streams.

The following are the modifications which I introduce according to circumstances in the above general but complete mode of procedure.

(*a.*) When the sewage is to be thrown into the open sea at some distance from a town or into a large river (in which case complete purification is unnecessary) the first part of the process is alone required. In this case if cement or mineral manures cannot be manufactured (or are unsaleable) I convert the whole of the deposit obtained from the precipitation in tank No. 1 (in this case the only one) into charcoal to be employed generally as a disinfecting agent, such as for the cages of the man-holes of the town drains, or I may cause it to absorb the ammoniacal vapours arising from the distillation of other portions of the sludge, or use it for the deodorizing of cesspools, &c., and finally sell the compound for manure.

(*b.*) When the town, village, or place to be dealt with is too small for a mineral manure manufactory, and there is no demand for cement or agricultural lime, though the complete purification of the water is of the utmost consequence, I precipitate with lime and dry and roughly carbonize the resulting deposit in mounds, kilns, or otherwise, and employ the charcoal so obtained for purifying the water by filtration through filter beds of this carbonized substance alone, or of this substance mixed with gravel or burned clay; or the carbonized substance may be spread on the surface of the soil to be used as a filter bed for downward intermittent filtration.

(*c.*) When the town is so situated that neither lime nor cement prove readily marketable in the vicinity, but the clarified sewage can be advantageously employed in farming operations, I precipitate with lime, convert the deposit into charcoal, and sell or employ the charcoal for general disinfecting purposes, as in case (*a*).

(*d.*) When favorable conditions for the preparation of phosphatic and ammoniacal manure offer themselves, and such manures though not highly concentrated obtain a ready sale, and agricultural lime and cement are not in demand, I convert the lime deposit into charcoal and use it for filtering beds, or stir it with the sewage to be purified as a powder in combination with one or more of the precipitants described in the before-mentioned Letters Patent, dated Twentieth March, One thousand eight hundred and seventy-two, No. 849.

(*e.*) When there is a demand for mineral manures, and it is essential that the manures resulting from the different processes should be as rich as possible in fertilizing elements, I convert a part only of the lime deposit into charcoal and the remainder into agricultural lime, and I employ the charcoal in the final purification of the water only after the noxious compounds (suspended and in solution in the sewage) have been as far as possible removed by the various precipitation processes above referred to.

It will be seen from the foregoing remarks and references that the chief novelty of the process, so far as I have described it, consists essentially in the preparation of charcoal from the deposit which is obtained by precipitating sewage by the lime process, and in using the charcoal so prepared with or without other chemicals, (A) for the removal of the organic matters from the clarified and partially purified effluent which results from such lime process, (B) for other disinfecting and deodorizing purposes.

Having set forth generally the nature of my process, and wherein its chief novelty consists, I now proceed to describe in detail the mode of conducting the operations necessary in such cases as are specified under heads (*d*) and (*e*), which embrace those under heads (*a*), (*b*), (*c*).

To effect the preliminary lime precipitation, in lieu of using fat or pure lime or such meagre limes as the immediate neighbourhood may afford, I employ by preference calcined magnesian limestone or dolomite, and this I do in a manner which I consider to be novel.

Lime being considerably more soluble in water than magnesia I take advantage of this difference of solubility to effect their separation, and I employ clarified sewage water pumped back for the purpose as the solvent.

The magnesian lime is stirred in suitable vessels with a sufficient quantity of such water to dissolve out the lime present, and after settlement the supernatant water charged with lime in solution and some magnesia is run into the raw sewage so as to cause a precipitation in a tank, which I call tank No. 1. The deposit thus produced I collect dry, and make into suitable forms for burning, such as bricks or balls. These are introduced into a double kiln, one compartment of which is employed in the conversion of the deposit into agricultural lime or cement, and for supplying the heat which is to effect the carbonization of a second portion of the material introduced into the other compartment after the manner sometimes practised in the preparation of peat charcoal.

The ammonia, tarry matters, and other products of distillation from the second compartment I sometimes collect by well-known methods, and at other times I employ them for the sake of the heat generated in their combustion, for such heat can be utilized for drying fresh portions of the deposit. The charcoal thus produced will be found to possess in great intensity the properties of animal charcoal. Its deodorizing qualities are very great, and still more so its properties of decolorizing liquids. The efficiency of the charcoal would not be injured by the use of soluble salts of iron and alumina or other chemicals in conjunction with the lime, but any useful purpose they might serve would be more than counterbalanced by the increase of cost they would entail upon the process. It is quite unnecessary that any other precipitant than lime or any other carbonaceous substance than sewage precipitates should be used in the production of this peculiar and highly efficient form of charcoal.

The undissolved magnesia which remains behind in the vessels in which the lime solution is prepared is reserved for conversion (by well known processes) into phosphate of magnesia, to be employed in the extraction of the ammonia from the sewage water or for conversion into other salts of magnesia.

The clarified effluent from tank No. 1 is then treated (as is fully described in the aforesaid Letters Patent, dated Twentieth March, One thousand eight hundred and seventy-two, No. 849,) with soluble phosphate of lime or magnesia and hydrated phosphate of magnesia for the purpose of recovering the ammonia and nitrogen in the sewage water, or with hydrated phosphate of magnesia only. These phosphate salts may be either used alone or mixed with the charcoal in the state of powder prepared from the lime deposit in No. 1 tank, or they may be used alone and the charcoal be employed as a filtering medium between the different precipitations in tanks 2 and 3, referred to in the aforesaid Patents.

The last plan is that which I prefer to employ when the tanks are of insufficient size to produce a clear effluent after each precipitation process, or when the fall is too little to admit of the supernatant water being drawn off from the different tanks after subsidence of the precipitated matters. In such cases by employing the charcoal as an upward filtering medium all the particles of solid matter (either released from solution or added as precipitants and deodorants) will be retained in their own compartments, though the flow of sewage be continuous. When the charcoal after such use is saturated with organic matter it may be disposed of as manure, or be revivified by exposure to air or heat.

For use as manure the intercepted particles of phosphate of lime and ammoniacal phosphate of magnesia will greatly increase its value. The nitrogenous matters retained by the charcoal will also add to its fertilizing properties.

When, as in case (*d*) large supplies of charcoal are available, and powdered charcoal is agitated in the sewage water with the phosphate salts, the mixed deposit obtained may be added to the charcoal removed from the filtering beds and the compound may be sold as manure. The powdered charcoal agitated with the sewage water should always be kept in considerable excess of what is required for the removal of the organic matter of the charge of sewage at the time acted upon to ensure that the water may be well scoured by it, or to make up for the want of fluidity in the charcoal particles. These can of course purify the water only so far as they come into contact with each atom of it.

The effluent from tank No. 3, which will contain a certain quantity of phosphate of magnesia dissolved by the sewage water in its passage through that tank, is then treated with lime or with dolomitic lime for case (*e*), or with lime and charcoal mixed for case (*d*), and the effluent is finally purified by filtration through a bed of charcoal prepared from the same lime deposit. Foul water so treated will be deprived of its hardness and be fit to be run into any watercourse without injury to those who may drink of the stream.

The efficacy of charcoal employed in the filtration of sewage water which has been subjected to the above described operations can be readily understood.

The lime process applied in tank No. 1 will not only remove the suspended impurities but will extract from fifty to sixty per cent. of the dissolved nitrogen. The various precipitations carried out in tanks Nos. 2, 3, and 4 will reduce the amount of dissolved nitrogenous matter to a minute quantity; and thus when the water reaches the final charcoal filtering bed with its active purifying properties unexhausted by the great contaminating powers of raw sewage, so little clogging of the pores of the charcoal will take place that it will continue to purify the water with scarcely diminished activity for long periods.

In reference to case (*c*) it is unnecessary to give any additional details. Complete purification in that case is neither necessary nor desirable. Clarification is all that is required as a preliminary to irrigation, and it would be objectionable to remove more of the fertilizing element of the sewage water than can be avoided. It will happen however in many such cases that a large portion of the inhabitants use cesspools or movable receptacles for the excreta, and throw the kitchen washings, &c., only into the drains. In such cases the charcoal derived from the lime deposit in tank No. 1 comes in as a valuable aid, and may be used as an absorbent or as a deodorant, and may be made available in conjunction with filters of hydrated phosphate of magnesia (as specified by me under my Patent of Twentieth March, One thousand eight hundred and seventy-two, No. 849,) in retaining and rendering capable of carriage the fertilizing elements of the excreta.

By urging the temperature of the kiln (in which the charcoal is prepared) to the point at which the carbon of the compound and the carbonic acid of the carbonate of lime present will react on one another the production of lime mixed with the charcoal will be the result. This compound if used with excreta or night soil will effect the decomposition of the urea of the urine with the production of ammonia, and the retention of the phosphoric acid in solution in the liquid. The ammonia thus produced will be then absorbed by the filter of phosphate of magnesia.

In some cases I apply pressure to the deposits from which the charcoal is prepared in order to give to the product a greater degree of hardness, which is of advantage when the charcoal is employed for filtering beds.

Having now described my Invention, and the means whereby I carry the same into effect, I wish it to be understood that under the above in part recited Letters Patent I claim,—

The mode or modes herein set forth of treating sewage or foul water and sewage deposits, and the deposits and clarified liquid derived from the precipitation of such foul water by lime or dolomitic lime.

And also the application of the solid products obtained therefrom (in combination or not with the other chemicals specified) for recovering the fertilizing elements contained in sewage matters, and for the manufacture of manure as herein set forth.

In witness whereof, I, the said Henry Young Darracott Scott, have hereunto set my hand and seal, the Twentieth day of February, in the year of our Lord One thousand eight hundred and seventy-three.

HENRY Y. D. SCOTT. (L.S.)

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